



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

Nuclear Energy Enabling Technologies (NEET)

Advanced Sensors and Instrumentation (ASI)

Suibel Schuppner
Office of Nuclear Energy

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Background

■ I&C functions as the nervous system of a NPP

- Measure important system parameters
- Provide control input to maintain safety limits
- Provide awareness of plant condition

■ I&C systems are one of the most extensive non-building structures in any NPP

- 10,000 sensors
- 5,000 Km of I&C cables

■ I&C systems in NPP are aging

- Reliability degrades
- Maintenance cost increases

■ Replacing traditional analog I&C systems with digital I&C poses a challenge to ensure:

- reliability, accuracy, improvement, performance are met
- comparable degree of diversity and defense-in-depth for safety significant functions are maintained





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A Different Approach is Needed

- Encourage deployment of current technology
- Proven methods for maintaining and modernizing technology in place
- Engagement of stakeholders
- New technology needs to factor aging and replacement
- Technical basis for licensing for nuclear deployment

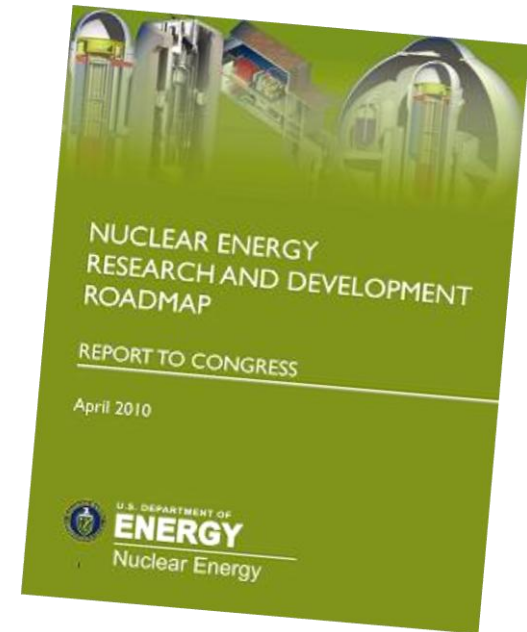




Federal Role

DOE-NE needs to support the creation of new innovative I&C technology for current and future nuclear systems that will:

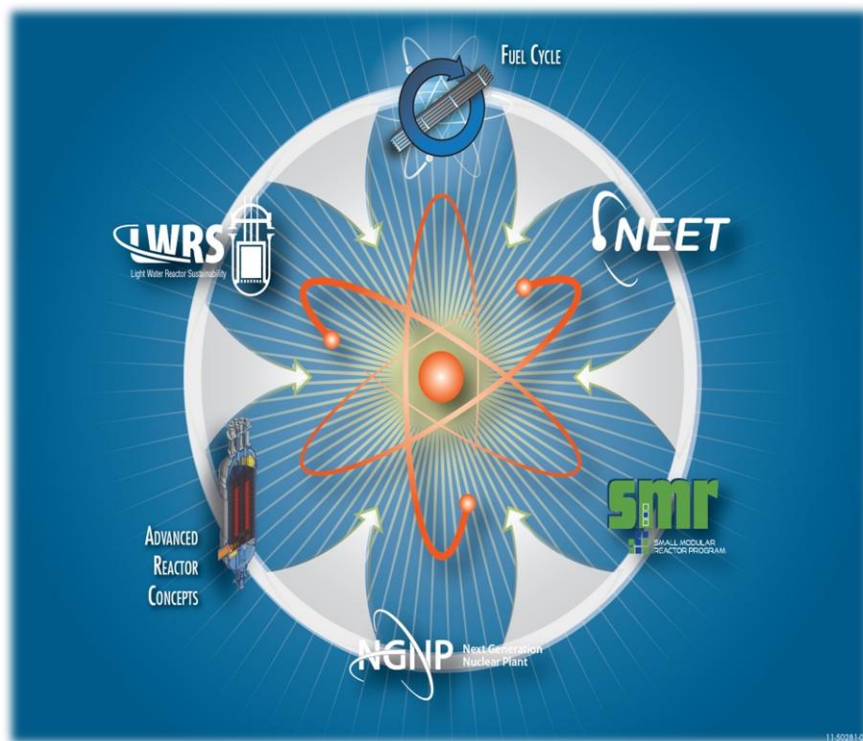
- Make current systems more sustainable
- Improve understanding, confidence and transition to new technologies
- Support technical basis needed for deployment



“The development and implementation of digital instrumentation and control systems will benefit current reactors as well as future reactors. Advanced instrumentation and control systems will also benefit future fuel cycle facilities. Safeguard technology development also relies on advanced instrumentation and plant control systems through safeguards-by-design.”



Current DOE-NE I&C Research



- Unique I&C issues of individual DOE-NE R&D Programs are addressed by each individual program
- Competitive awards in the I&C area are awarded under NEUP and SBIR/STTR programs
- Common challenges and needs across programs will be addressed under the Advanced Sensors and Instrumentation program



Advanced Sensors and Instrumentation Crosscutting Program

- Initiated in January 2012
- Tightly coupled to NE R&D Programs to:
 - Address needs & requirements shared by multiple programs.
 - Not constrained by a single, programmatic focus – can look beyond immediate technical needs to see long-range issues (e.g., cyber security)
- Driven by common technical gaps (e.g. high temperature tolerant sensors)
- Required to overcome near-term technical challenges (e.g., resilient and adaptive digital controls)
- Support a key decision (e.g., advanced human-system interface technologies)
- Develop breakthroughs (e.g., embedded I&C and hardened electronics)





ASI Coordinated Scope

■ Technical constituency

- I&C leads representing NE R&D programs provide input

■ Common ASI objectives

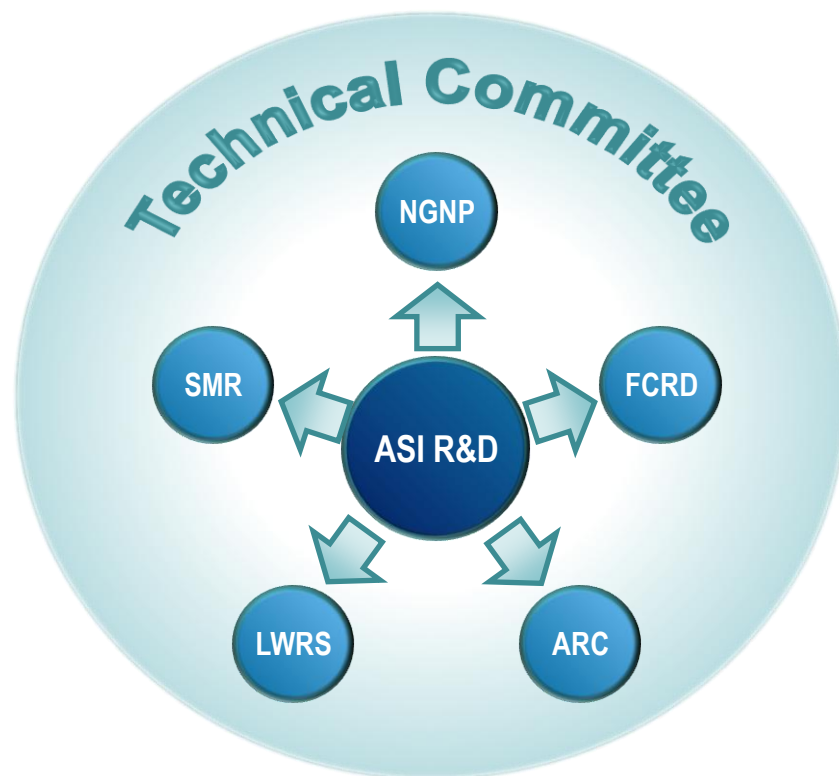
- Goal-driven approach to address gaps based on:
 - Commonality
 - Capability development
 - Enabling characteristics
- Coordinated execution of R&D

■ Anticipate long term needs

- Deployment challenges
- Regulatory issues

■ Leverage results

- Coordination to ensure scalability by individual R&D programs
- Timing of needed technology capabilities





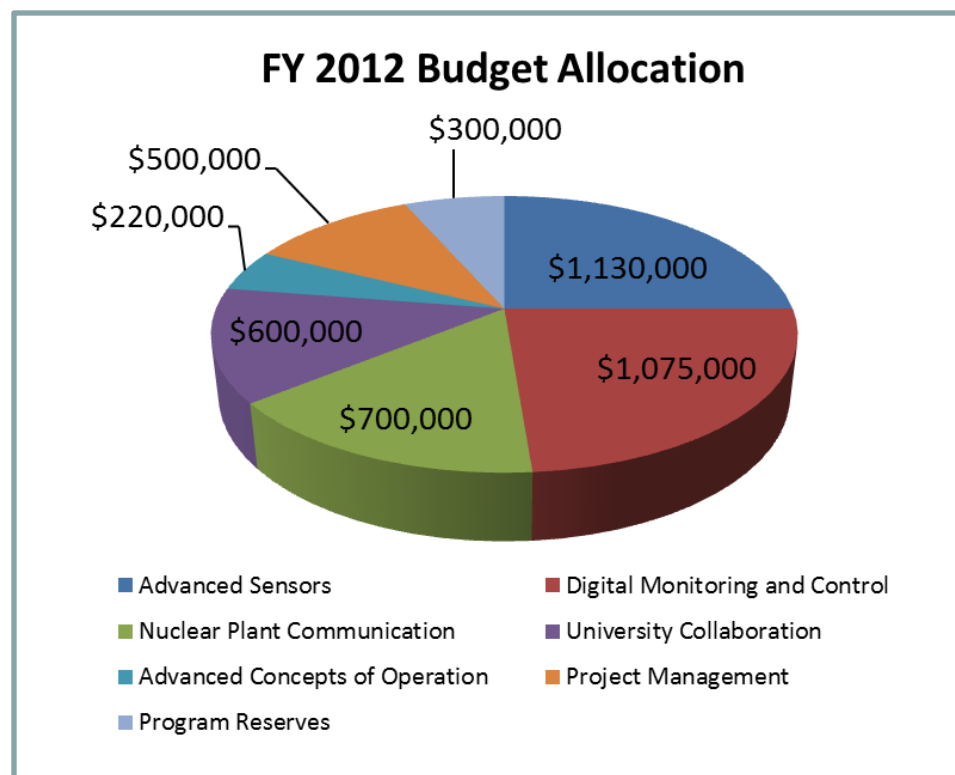
ASI Budget

■ FY 2012 (\$4,525,000)

- Develop a detailed research plan that crosscuts key DOE programs and addresses technology risks associated with this program area
- Initiate research in the following research pathways:
 1. Advanced Sensors
 2. Advanced Concepts of Operation
 3. Digital Monitoring and Control
 4. Nuclear Plant Communication

■ FY 2013 (\$3,053,000)

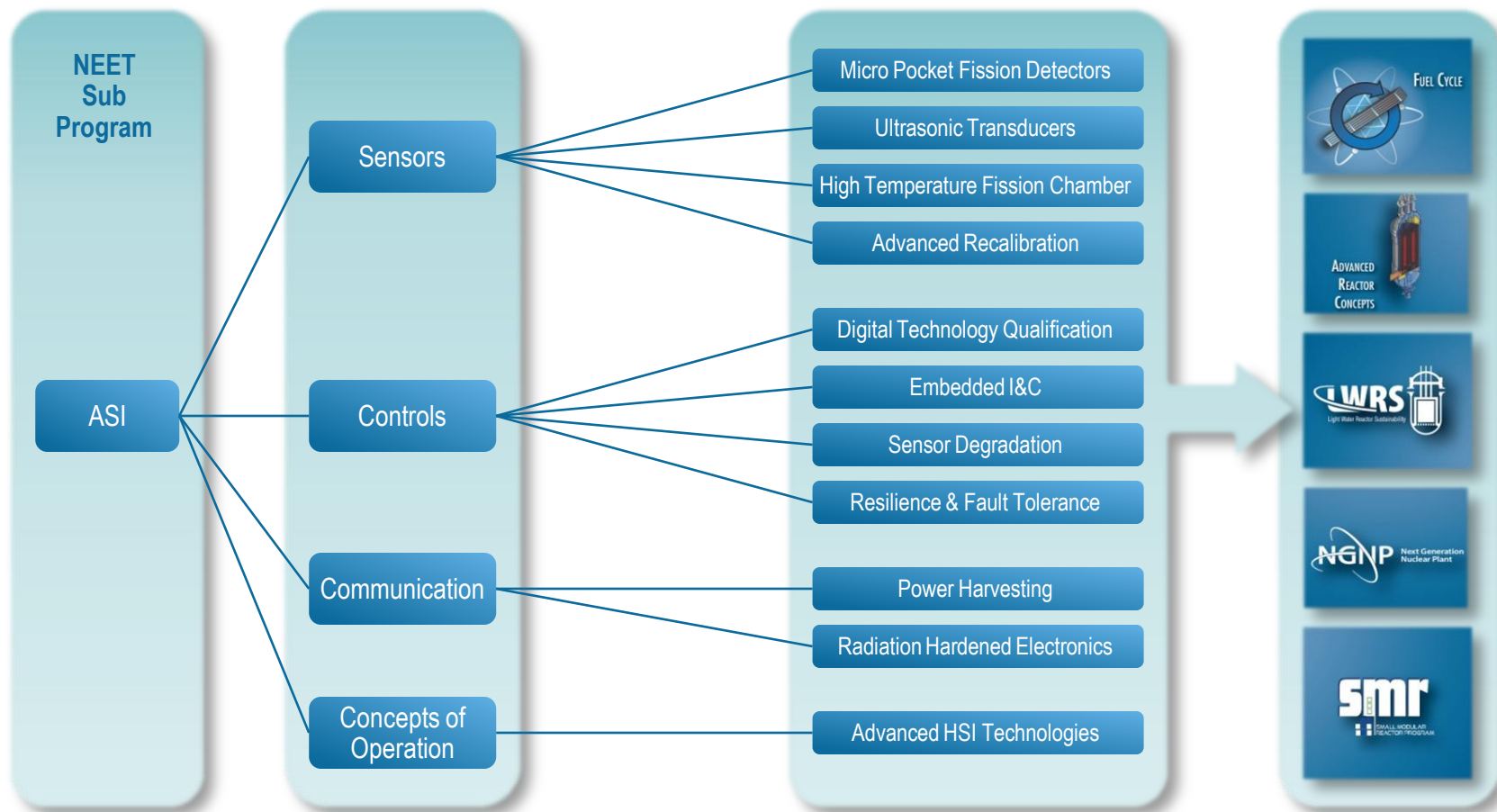
- Continue top-priority research initiated in FY 2012





The ASI – NE R&D Program Relationship

R&D Topics ...target gaps that will be met through... **R&D Projects** ... that map to... **NE R&D Programs Needs**





Address Programmatic Needs

KEY		SENSORS				CONTROLS				COMMUNICATIONS		CONCEPTS OF OPERATION
✓	PRIMARY	MICRO POCKET FISSION DETECTORS	ULTRASONIC TRANSDUCERS	HIGH TEMPERATURE FISSION CHAMBER	DYNAMIC RECALIBRATION	DIGITAL TECHNOLOGY QUALIFICATION	EMBEDDED INSTRUMENTATION & CONTROLS	SENSOR DEGRADATION	RESILIENCE & FAULT TOLERANCE	POWER HARVESTING	RADIATION HARDENED ELECTRONICS	ADVANCED HUMAN-SYSTEM INTERFACE TECHNOLOGIES
✓	SECONDARY											
FUEL CYCLE R&D		✓	✓		✓			✓			✓	
ADVANCED REACTOR CONCEPTS		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
LIGHT WATER REACTOR SUSTAINABILITY			✓		✓	✓		✓	✓	✓	✓	✓
NEXT GENERATION NUCLEAR PLANT		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
SMALL MODULAR REACTORS		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

■ Support near-term programmatic needs

- Fuel & material studies, integral tests

■ Provide new capabilities for measurement and control

- Sensors for high temperature, corrosive environments; radiation tolerance; digital technology qualification

■ Address long lead R&D needs for successful deployment

- Resilient controls for new processes
- Advanced operational concepts requiring modifications or exemptions to existing regulation



Benefits Extend Beyond Programmatic Goals

- Micro Pocket Fission Detectors
- Ultrasonic Sensors for In-pile Fuel Irradiation
- High Temperature Materials
- Radiation Hardened Electronics

Experiments

- High Temperature Fission Chambers
- Embedded Instrumentation & Controls
- Advanced HIS Technologies
- Radiation Hardened Electronics
- Digital Technology Qualification

Needed
Technologies

Accident
Tolerance

- Radiation Hardened Electronics
- High Temperature Sensor Materials
- Sensor Degradation Controls
- Power Harvesting Technologies

Robust
Systems

- Self Calibrating Sensors
- Sensor Degradation Controls
- Power Harvesting Technologies
- Resilient Controls



Coordination

■ Integrated Research Plan

- High Level Milestone – Due Sept. 30, 2012
- Includes all I&C research in DOE-NE
- Identifies the gaps/needs of the DOE-NE R&D Programs
- Avoids duplication and provides coordination
- Provides prioritization of research

■ Meetings

- Weekly Program Status
- Monthly Report
- Quarterly with R&D Programs
- Biannual workshop
- Annual Review

In FY12, the ASI subprogram will produce an Integrated Research Plan to describe the activities and interactions that drive scope, the R&D efforts, milestones, deliverables, and outcomes that enable NE's R&D programs.



Conclusion

- I&C research is needed to support nuclear energy reactors and fuel cycle technologies
- R&D Programs will address unique I&C issues of individual programs
- Advanced Sensors and Instrumentation Program will address common challenges and coordinate DOE-NE I&C research
- ASI Research Plan will be issued on September 30, 2012

We need to ensure that future nuclear energy options leverage new I&C technologies to achieve safe, reliable, sustainable, and efficient operation